

AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions, and listings, of claims in the application:

1. (Currently amended) A gas concentration detecting apparatus comprising: ~~a gas concentration sensor including~~

a gas concentration sensor having a first cell and a second cell for sensing concentrations of oxygen and a specific gas in a measuring gas, respectively;

a power supply for supplying electric power to the gas concentration sensor; and

a current measurement device that measures an electric current flowing through the first and second cells of the gas concentration sensor,

wherein ~~the~~ first cell ~~of the gas concentration sensor having a solid electrolyte element,~~ and a pair of electrodes disposed on said solid electrolyte element for pumping out and in oxygen of a gas to be detected introduced into a chamber ~~charges or discharges excessive oxygen~~ contained in the measuring gas in order to detect the concentration of oxygen in the measuring gas based on an electric current flowing through the first cell measured by the current measurement device when a first voltage is applied to said first cell from the power supply, and outputs a first signal containing information about said concentration of oxygen in the measuring gas; and

a ~~the~~ second cell ~~of the gas concentration sensor having a solid electrolyte element and a pair of electrodes disposed on said solid electrolyte element for detecting~~ a ~~the~~ concentration of a ~~the~~ specific gas component of said ~~in the measuring gas after passing through said first cell,~~ with an oxygen concentration signal being outputted on the basis of a current flowing when a

~~voltage is applied to said first cell and~~ outputs a second signal containing information about a
~~specific gas concentration signal outputted based on the basis of a current flowing an electric~~
~~current flowing through the second cell measured by the current measurement device~~ when a
second voltage is applied to said second cell from the power supply; and

~~wherein a decision on completion of activation of said first cell and a decision on~~
~~completion of activation of said second cell are separately made in the middle of activation of~~
~~said gas concentration sensor, after starting energization of the gas concentration sensor~~
~~including the first and second cells, and a decision indicative of the activation of said second cell~~
~~is made after a decision is made that the activation of said first cell reaches completion~~ the
decision on completion of activation of said second cell is made after the activation of the first
cell is completed.

2. (Currently amended) The apparatus according to claim 1, wherein

~~said first cell electrode provided in said chamber is a specific gas inactive electrode~~
~~inactive in said specific gas component, while said second cell electrode provided in the same~~
~~chamber is a specific gas active electrode active in said specific gas component~~ comprises a pair
of first electrodes, each first electrode being reactively inactive with respect to the specific gas,
and

said second cell comprises a pair of second electrodes, each second electrode being
reactively active with respect to the specific gas.

3. (Currently amended) The apparatus according to claim 1, ~~wherein said gas~~
~~concentration sensor further includes~~ further comprising:

a third cell for detecting a residual oxygen concentration of said measuring gas after passing through said first cell, ~~so that~~

wherein an amplitude of said first voltage to be applied to said first cell from the power supply is variably controlled on the basis of a detection result in said third cell.

4. (Currently amended) The apparatus according to claim 1, wherein said first cell comprises a first solid electrolyte element that is sandwiched between first electrodes and generates an electromotive force between the first electrodes, the electromotive force being a function of the oxygen concentration in the measuring gas, and said second cell comprises a second solid electrolyte element that is sandwiched between second electrodes and generates an electromotive force between the second electrodes, the electromotive force being a function of the specific gas concentration in the measuring gas, the apparatus further comprising:

an element resistance ~~detecting~~ monitor means for ~~detecting~~ monitoring a resistance value of at least one of said first ~~and or~~ second solid electrolyte ~~element~~ element ~~of any one of~~ said cell to implement control on to control a degree of ~~element~~ activation of the cell ~~so that in order to keep~~ the ~~detected element~~ resistance value of the corresponding solid electrolyte element ~~of kept~~ at a first predetermined target value after starting energization of the gas concentration sensor, and the transition of said element resistance value detected by said element resistance ~~detecting means is monitored in the middle of the activation of said gas concentration sensor, and when said element resistance value reaches an activation decision value based upon said target value, a decision is made that said first cell reaches its activation~~

wherein the monitored resistance value of the solid electrolyte element which is monitored by the element resistance monitor is compared with a second predetermined target value in order to judge whether or not the activation of the first cell is completed.

5. (Currently amended) The apparatus according to claim 4, wherein, ~~when~~ if a condition is satisfied, a decision is made that said first cell reaches the activation, the condition indicating that after starting energization of the gas concentration sensor including the first and second cells, said element resistance value of the monitored solid electrolyte element detectedmonitored by said element resistance detecting meansmonitor in the middle of the activation of said gas concentration sensor reaches said activation decision second predetermined target value, and a predetermined period of time elapses from a time when said resistance value of the monitored solid electrolyte element reaches said activation decision second predetermined target value, a predetermined period of time elapses after the detected element resistance value reaches said activation decision value, a decision is made that said first cell reaches the activation.

6. (Currently amended) The apparatus according to claim 4, wherein, ~~when~~ if a condition is satisfied, a decision is made that said first cell reaches the activation, the condition indicating that after starting energization of the gas concentration sensor, said element resistance value of the solid electrolyte element detectedmonitored by said element resistance detecting meansmonitor in the middle of the activation of said gas concentration sensor reaches said activation decision second predetermined target value and a detection measured electric current flowing in the first cell of the gas concentration sensor measured by said first cell falls the

electric current measurement device is within a predetermined range, a decision is made that said first cell reaches the activation.

7. (Currently amended) The apparatus according to ~~claim 1~~ claim 2, further comprising:

a heater for activating the first and second electrodes; and

a heater energizing means~~device for implementing energizing control on a~~ the heater for the element activation so that after starting energization of the gas concentration sensor including the first and second cells,

wherein when if a condition is satisfied, a decision is made that said first cell reaches the activation, the condition indicating a predetermined period of time elapses after the start of the heater energizing control in the middle of the activation of said gas concentration sensor, a decision is made that said first cell reaches the activation from starting energization of the heater.

8. (Currently amended) The apparatus according to claim 1, ~~wherein an elapsed time after the decision is made that said first cell reaches the activation is measured and, when the elapsed time reaches a predetermined time, a decision is made that said second cell reaches the activation~~

wherein if a condition is satisfied, a decision is made that said second cell reaches the activation, the condition indicating that a predetermined time elapsed from activation of the first cell of the gas concentration sensor is completed.

9. (Currently amended) The apparatus according to claim 8, wherein, ~~when an elapsed time after said first cell reaches the activation reaches a predetermined time and a detection current by said second cell falls within a predetermined range, a decision is made that said second cell reaches activation~~ if a condition is satisfied, a decision is made that said second cell reaches the activation, the condition indicating that a predetermined time elapsed after activation of the first cell of the gas concentration sensor is completed, and a measured electric current flowing in the second cell of the gas concentration sensor measured by the electric current measurement device is within a predetermined range.

10. (Currently amended) The apparatus according to claim 8, further comprising:
a third cell for detecting a residual oxygen concentration of said measuring gas after passing through said first cell ~~so that,~~

wherein, if a condition is satisfied, a decision is made that said second cell reaches the activation, ~~when an elapsed time after said first cell reaches the activation reaches a predetermined time~~ the condition indicating that a predetermined time elapsed after activation of the first cell of the gas concentration sensor is completed, and a ~~detection~~ measured electric current flowing in the third cell of the gas concentration sensor measured by said third cell falls the electric current measurement device is within a predetermined range ~~a decision is made that said second cell reaches activation.~~

11. (Currently amended) The apparatus according to claim 8, wherein said predetermined time is determined on the basis of a time needed for discharging all oxygen absorbed onto ~~a specific gas active~~ one of electrode electrodes of said second cell.

12. (New) A gas concentration detecting method for detecting a gas concentration in a measuring gas flowing through a gas concentration detecting apparatus including a gas concentration sensor having first and second cells for sensing a concentration of oxygen in a measuring gas and a concentration of a specific gas in the measuring gas, a power supply for supplying electric power to the gas concentration sensor, and a current measurement device which measures an electric current following through the first and second cells of the gas concentration sensor, the method comprising:

detecting the concentration of oxygen in the measuring gas based on an electric current flowing through the first cell measured by the current measurement device when a first voltage is applied to said first cell from the power supply, the electric current being generated by charging or discharging an excessive oxygen in the measuring gas into or from the first cell, respectively;

detecting the concentration of the specific gas in the measuring gas based on an electric current flowing through the second cell by the current measurement device when a second voltage is applied to said second cell from the power supply after the oxygen concentration in the measuring gas is detected;

judging whether or not an activation of the first cell of the gas concentration sensor is completed after the gas concentration sensor is started to be energized; and

judging whether or not an activation of the second cell of the gas concentration sensor is completed, only if the activation of the first cell of the gas concentration sensor is completed.

13. (New) The gas concentration detecting method according to claim 12, wherein the gas concentration sensor further comprises a third cell into which the measuring gas is injected after passing through the first cell, the method further comprising:

detecting a concentration of residual oxygen in the measuring gas based on an electric current flowing through the third cell measured by the current measurement device; and

adjusting an applied voltage applied to the first cell from the power supply based on a result of detecting the residual oxygen concentration in the measuring gas so as to reduce the residual oxygen after the oxygen concentration is detected in the first cell.

14. (New) The gas concentration detecting method according to claim 12, wherein the first cell comprises a first solid electrolyte element that is sandwiched between first electrodes and generates an electromotive force between the first electrodes, the electromotive force being a function of the oxygen concentration in the measuring gas, and said second cell comprises a second solid electrolyte element that is sandwiched between second electrodes and generates an electromotive force between the second electrodes, the electromotive force being a function of the specific gas concentration in the measuring gas, the method further comprising:

monitoring a change in a resistance value of at least one of said first or second solid electrolyte element to control a degree of activation of the cell in order to keep the resistance value of the corresponding solid electrolyte element at a first predetermined target value; and

comparing the resistance value with a second predetermined target value in order to judge whether or not the activation of the first cell is completed.

15. (New) The gas concentration detecting method according to claim 14, further comprising:

measuring an elapsed time after the resistance value of the monitored solid electrolyte element reaches the second predetermined target value; and

determining that the activation of the first cell is completed only if a condition is satisfied, the condition indicating that after starting energization of the gas concentration sensor including the first and second cells, the resistance value of the solid electrolyte element reaches said second predetermined target value, and a predetermined time elapses from a time when the resistance value reaches the second predetermined target value.

16. (New) The gas concentration detecting method according to claim 14, further comprising:

determining that the activation of the first cell is completed only if a condition is satisfied, the condition indicating that after starting energization of the gas concentration sensor including the first and second cells, the resistance value of the solid electrolyte element reaches the second predetermined target value and a measured electric current flowing in the first cell of the gas concentration sensor measured by the electric current measurement device is within a predetermined range.

17. (New) The gas concentration detecting method according to claim 12, wherein the gas concentration detecting apparatus further includes a heater in order to activate at least one of the first or second electrodes of the gas concentration sensor, the method further comprising:

energizing the heater after starting energization of the gas concentration sensor; and

determining that the activation of the first cell is completed only if a condition is satisfied, the condition indicating that a predetermined time elapses from energization of the heater is started.

18. (New) The gas concentration detecting method according to claim 12, further comprising:

determining that the activation of the second cell is completed only if a condition is satisfied, the condition indicating that a predetermined time elapsed from activation of the first cell of the gas concentration sensor is completed.

19. (New) The gas concentration detecting method according to claim 12, wherein the specific gas is nitrogen oxides.

20. (New) A gas concentration detecting apparatus for sensing concentrations of oxygen and a specific gas of a measuring gas, the measuring gas flowing through a gas concentration sensor having first and second cells, the gas concentration detecting apparatus comprising:

means for supplying electric power to the gas concentration sensor;

means for measuring an electric current flowing through the first cell and the second cell of the gas concentration sensor;

means for detecting the concentration of oxygen in the measuring gas based on an electric current flowing through the first cell measured by the electric current measuring means when a first voltage is applied to said first cell from the power supplying means, the electric current

being generated by charging or discharging an excessive oxygen in the measuring gas into or from the first cell, respectively;

means for detecting the concentration of the specific gas in the measuring gas based on an electric current flowing through the second cell by the electric current measuring means when a second voltage is applied to said second cell from the power supplying means after the oxygen concentration in the measuring gas is detected;

means for judging whether or not an activation of the first cell of the gas concentration sensor is completed after the gas concentration sensor is started to be energized; and

means for judging whether or not an activation of the second cell of the gas concentration sensor is completed, only if the activation of the first cell of the gas concentration sensor is completed.

21. (New) The gas concentration detecting apparatus according to claim 20, wherein the gas concentration sensor further comprises a third cell into which the measuring gas is injected after passing through the first cell, and the gas concentration detecting apparatus further comprises:

means for detecting a concentration of residual oxygen in the measuring gas based on an electric current flowing through the third cell measured by the current measuring means; and

means for adjusting an applied voltage applied to the first cell from the power supplying means based on a result of detecting the residual oxygen concentration in the measuring gas so as to reduce the residual oxygen after the oxygen concentration is detected in the first cell.

22. (New) The gas concentration detecting apparatus according to claim 20, wherein the first cell further comprises a first solid electrolyte element that is sandwiched between first electrodes and generates an electromotive force between the first electrodes, the electromotive force being a function of the oxygen concentration in the measuring gas, and said second cell further comprises a second solid electrolyte element that is sandwiched between second electrodes and generates an electromotive force between the second electrodes, the electromotive force being a function of the specific gas concentration in the measuring gas, and the gas concentration detecting apparatus further comprises:

means for monitoring a change in a resistance value of at least one of said first or second solid electrolyte element to control a degree of activation of the cell in order to keep the resistance value of the corresponding solid electrolyte element at a first predetermined target value; and

means for comparing the resistance value with a second predetermined target value in order to judge whether or not the activation of the first cell is completed.

23. (New) The gas concentration detecting apparatus according to claim 22, further comprising:

means for measuring an elapsed time after the resistance value of the monitored solid electrolyte element reaches the second predetermined target value; and

means for determining that the activation of the first cell is completed only if a condition is satisfied, the condition indicating that after starting energization of the gas concentration sensor including the first and second cells, the resistance value of the solid electrolyte element

reaches said second predetermined target value, and a predetermined time elapses from a time when the resistance value reaches the second predetermined target value.

24. (New) The gas concentration detecting apparatus according to claim 22, further comprising:

means for determining that the activation of the first cell is completed only if a condition is satisfied, the condition indicating that after starting energization of the gas concentration sensor including the first and second cells, the resistance value of the solid electrolyte element reaches the second predetermined target value and a measured electric current flowing in the first cell of the gas concentration sensor measured by the electric current measuring means is within a predetermined range.

25. (New) The gas concentration detecting apparatus according to claim 20, further comprising:

a heater in order to activate at least one of the first or second electrodes of the gas concentration sensor;

means for energizing the heater after starting energization of the gas concentration sensor; and

means for determining that the activation of the first cell is completed only if a condition is satisfied, the condition indicating that a predetermined time elapses from energization of the heater is started.

26. (New) The gas concentration detecting apparatus according to claim 20, further comprising:

means for determining that the activation of the second cell is completed only if a condition is satisfied, the condition indicating that a predetermined time elapsed from activation of the first cell of the gas concentration sensor is completed.

27. (New) The gas concentration detecting apparatus according to claim 20, wherein the specific gas is nitrogen oxides.